Introduction

This chapter focuses on several key issues at the heart of the current debate over the quality of our elementary and secondary mathematics and science education system. Trends in math and science achievement and coursetaking are examined first, both as system outputs and as the context for current reform efforts. Next, the chapter examines several quantifiable aspects of current reform efforts. Maintaining the science and engineering (S&E) pipeline and preparing all young people for an increasingly technological society are two goals driving reforms targeted to raise the academic bar for students and improve the quality of teaching. The desire to raise the academic expectations for all students has led states to both adopt standards specifying what students should know and be able to do and to implement new testing mechanisms to measure what students actually know.

Although it is widely recognized that education reforms cannot be successful without actively engaging teachers, comprehensive, valid measures of change in teacher quality are difficult to come by, leaving us to rely on currently available data. Indicators of teacher credentials, experience, and participation in professional development activities are presented, as well as data on how new teachers are being inducted into the profession. As access to computers and the Internet becomes more widespread in schools, the focus of the chapter turns toward understanding how IT is being implemented and how students are benefiting from its use. In conclusion, the adequacy of student preparation for higher education is examined as a lead into the discussion of college-level S&E in chapter 2.

This chapter emphasizes variation in both access to education resources (by school poverty level and minority concentration) and performance (by sex, race/ethnicity, and family background) as data availability allows. A distinction is also made between mathematics and science when the policy implications of data are different or the data tell different stories.

How Well Do Our Students Perform in Mathematics and Science?

U.S. and internationally comparable achievement data result in a mixed report card for the United States. Although performance on assessments of mathematics and science achievement by the National Assessment of Educational Progress (NAEP) has improved since the 1970s, few students are attaining levels deemed Proficient or Advanced by a national panel of experts, and the performance of U.S. students continues to rank substantially below that of students in a number of other, mostly Asian, countries. This cross-national achievement gap appears to widen as students progress through school. This section describes progress in student performance, both long-term trends based on NAEP curricular frameworks developed in the late 1960s and more recent trends that track performance across items aligned with more current standards. International comparisons are then used to benchmark U.S. performance in these subjects.

Long-Term Trends in Math and Science Performance

Generally, mathematics and science performance on the NAEP long-term trend assessment declined in the 1970s, increased during the 1980s and early 1990s, and has remained mostly stable since that time. (See sidebar, "The NAEP Trends Study.") NAEP mathematics achievement increased among 9-, 13-, and 17-year-old students since the early 1980s, although most of these gains occurred before 1992. (See figure 1-1.) Although the average scale scores of 17-year-olds declined by 6 points between 1973 and 1982, scores increased by 9 points between 1982 and 1992 and remained at about the same level through 1999 (National Center for Education Statistics (NCES) 2000e). These gains since 1982 were substantial, equating to about a quarter of the difference between the mathematics scores of 13- and 17-year-olds (an 8-point difference is roughly equivalent to a year of schooling between these ages). Substantial gains were also made by 9- and 13-year-olds between 1982 and 1999: 8 and 13 points, respectively.

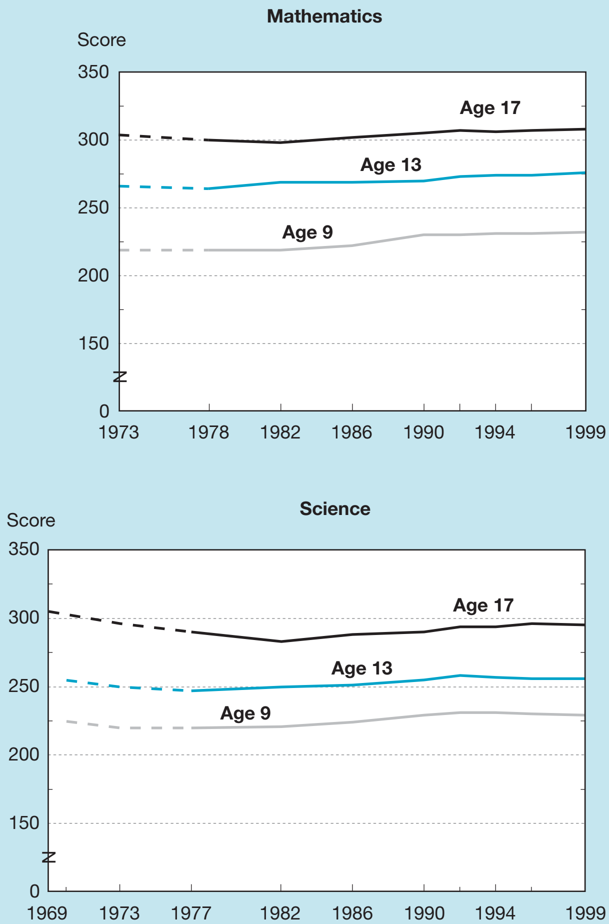
NAEP science performance over the past three decades has generally mirrored that of math: scores declined during the 1970s but increased in the 1980s and early 1990s. Because the first science assessments occurred before the first math assessments (1969 for 17-year-olds and 1970 for 13- and 9-year-olds), science achievement can be tracked over a longer period. Results for 17-year-olds show an initial 22-point decline between 1969 and 1982. In the decade between 1982 and 1992, an increase in the average score erased about half of that decline; since 1992, scores have been stable. (See figure 1-1.) Although 17-year-olds had higher science scores in 1999 than their counterparts in 1982, the average 1999 score remained 10 points below the average score in 1969. Gains since the early 1980s for 13- and 9-year-olds in science have essentially returned the average scores of these cohorts to levels similar to (for 13-year-olds) or higher than (for 9-year-olds) those posted in 1970.

A persistently wide gap in NAEP scores between low- and high-performing students remains. For example, the gap between the average mathematics scores of the highest and lowest performing quartiles for 17-year-old students was 73 points in 1999, a gap similar in size to the difference between the average scale scores for 17- and 9-year-olds in 1999 (roughly equivalent to eight years of schooling). Similar gaps have persisted for 9- and 13-year-olds as well. Efforts to apply uniformly high standards to all children need to confront the large variation in performance that currently exists in our schools.

Trends in Performance by Sex

Differences in the academic performance of female and male students on the NAEP long-term trend assessment appear as early as age 9 and persist through age 17. Although girls have consistently outperformed boys in reading and writing, gaps between the sexes in mathematics and science performance in the early grades have been much narrower and have varied over time. In 1999, 9-year-old girls had higher

Figure 1-1.
Trends in average scale scores in mathematics and science: 1969–1999



NOTE: Dashed lines represent extrapolated data.

SOURCE: National Center for Education Statistics, *NAEP 1999 Trends in Academic Progress: Three Decades of Student Performance,* NCES 2000-469. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2000e.

Science & Engineering Indicators – 2002

The NAEP Trends Study

The National Assessment of Educational Progress's (NAEP's) long-term trend assessments have been the primary means for tracking the achievement trends of 9-, 13-, and 17-year-olds in science since 1969 and in mathematics since 1973. These primarily multiple-choice tests have remained substantially the same since first given, allowing the measurement of student progress over the past three decades. The content of these assessments is "traditional" by today's standards. For example, the mathematics assessment measures student knowledge of basic facts, ability to carry out numerical algorithms using paper and pencil, knowledge of basic measurement formulas as they are applied to geometry problems, and ability to apply mathematics to daily living skills (such as those related to time and money). Calculators are permitted only on a few questions. The computational focus of the long-term trend assessment provides the opportunity to determine how our students are measuring up to traditional procedural skills, even as the calculator plays an increasingly greater role in today's mathematics curriculum. Both the content (see the section, "Benchmarking of Mathematics Performance Against Standards") and the populations assessed, which are age groups rather than grades, distinguish these assessments from the "National" NAEP, which is discussed in the next section.

Student performance on the long-term trend assessments is summarized on a 0- to 500-point scale for each subject area. Item response theory (IRT) was used to estimate average proficiency for the nation and various subgroups of interest within the nation. IRT models the probability of answering a question correctly as a mathematical function of proficiency or skill. The main purpose of IRT analysis is to provide a common scale by which performance can be compared across groups, such as those defined by age, assessment year, or subpopulations (e.g., race/ethnicity or sex). Although the use of IRT scaling in the NAEP Trends Study puts the scores of 9-, 13-, and 17-year-olds on the same scale, which facilitates comparisons across ages, the scores of students on the Third International Mathematics and Science Study (TIMSS) are scaled separately for each grade. Therefore, the scores are not comparable across grades.

SOURCE: NCES 2000e and <http://www.nces.ed.gov/naep3/mathematics/trends.asp>.

average reading scores than boys, although this gap has narrowed since 1971 (NCES 2000e). In mathematics, higher scores earned by girls in the 1970s shifted to higher scores earned by boys in the 1990s. In 1999, however, the difference between the scores of boys and girls was not statistically significant. In science, boys have tended to perform better than girls at age 9, although, as observed in mathematics, the difference in 1999 was not statistically significant.

Female and male achievement differences at age 9 remain nearly unchanged at age 13. For example, in 1999, the average reading proficiency score for a 13-year-old female was 12 scale points higher than for a 13-year-old male, and females scored at about the same level in math and 6 scale points lower than males in science (NCES 2000e). When 17-year-olds are assessed, female and male differences in reading persist. For example, in 1999, average reading proficiency for 17-year-old females was 13 scale points higher than for males of the same age. This corresponds to about 45 percent of the difference between the average scores of 13- and 17-year-olds in 1999. In other words, the gap in reading proficiency between females and males at age 17 is roughly equivalent to between 1.5 and 2 years of schooling.

In mathematics and science, boys have tended to score higher than girls, although the gap is narrower. A gap favoring 17-year-old males in mathematics narrowed from 8 points in 1973 to one that was statistically insignificant in 1999. (See figure 1-2.) The gap in science at this age narrowed from 16 points in 1973 to 10 points in 1999 (about a year's worth of science).

Trends in Performance by Race/Ethnicity

NAEP trend data on science and mathematics achievement of 17-year-olds between 1973 and 1999 suggest that the gap between whites and their black and Hispanic peers has narrowed but remains large.[1] Differences in percentile scores by race/ethnicity, that is, the score at which different percentages of a particular group (5, 25, 50, 75, or 95 percent) score at or below, provide an indication of the size of these gaps. (See figure 1-3.) For example, in 1999, 75 percent of white 17-year-olds scored 282 or above on the NAEP science test (the 25th percentile score), while only 25 percent of black 17-year-olds and fewer than 50 percent of Hispanic 17-year-olds scored at that level. In mathematics, the gap between blacks and whites appears to be somewhat narrower and the gap between whites and Hispanics somewhat wider. Gains by both high- and low-performing black and Hispanic students have narrowed the wide gaps that were in evidence since 1973, although there is little evidence that the gaps have continued to narrow in the 1990s, and some evidence that the gap between whites and blacks in mathematics has widened (NCES 2000e).

Gaps in mathematics achievement between whites and other racial/ethnic groups exist before entering high school, but evidence shows that these gaps widen for some groups during high school. In mathematics, the overall differences in 8th- to 12th-grade achievement gains show that blacks learn less than whites during high school, Hispanics and whites do not differ significantly, and Asians learn more than whites on average. However, when one compares blacks and whites completing the same number of math courses, the achievement gains during high school are not measurably (statistically) different. The Asian and white achievement gain differences are also generally reduced among students completing the same number of mathematics courses (NCES 1995). These data do not suggest, however, that coursetaking patterns alone lead to similar outcomes. The level of achievement that students from different backgrounds have attained before entering particular courses makes a difference, because parallel gains among students taking the same courses cannot close the gap. For example, NAEP data show that racial/ethnic differences in mathematics persist even among students who have completed similar courses at the time of assessment. The gap in average scores was 21 points between white and black 17-year-olds whose highest math course taken as of the 1996 assessment was algebra II; this gap is similar to the difference in scores observed between all 17-year-olds whose highest math course was algebra II and those whose highest course was geometry (NCES 2000b).

Benchmarking of Mathematics Performance Against Standards

In addition to the long-term trend data described above, NAEP periodically assesses the mathematics and science performance of students against more current frameworks of what students are expected to know in the 4th, 8th, and 12th grades (hereafter, referred to as the "National" NAEP).[2] Since 1990, the mathematics assessments have been based on a framework influenced by the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (NCTM 1989). The assessment framework contains five content strands (number sense, properties, and operations; measurement; geometry and spatial sense; data analysis, statistics, and probability; and algebra and functions). In addition to the five content strands, the assessments examine mathematical abilities (conceptual understanding, procedural knowledge, and problem solving) and mathematical power (reasoning, connections, and communication). Student mathematics performance is summarized on the NAEP mathematics scale, which ranges from 0 to 500. In addition, results for each grade are reported according to three achievement levels developed by NAGB: Basic, Proficient, and Advanced. These achievement levels are based on collective judgments by NAGB about what students should know and be able to do in mathematics.[3] The levels were defined by a broadly representative panel of teachers, education specialists, business and government leaders, and members of the general public. The Basic level denotes partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade. The Proficient level represents solid academic performance as determined by NAGB, and the Advanced level signifies superior performance. Although NCES still considers these proficiency levels developmental, they are used in this section to benchmark student math achievement.

Mathematics Performance by Achievement Level

Although mathematics trends in the NAEP long-term trend study were relatively flat during the 1990s, mathematics per-

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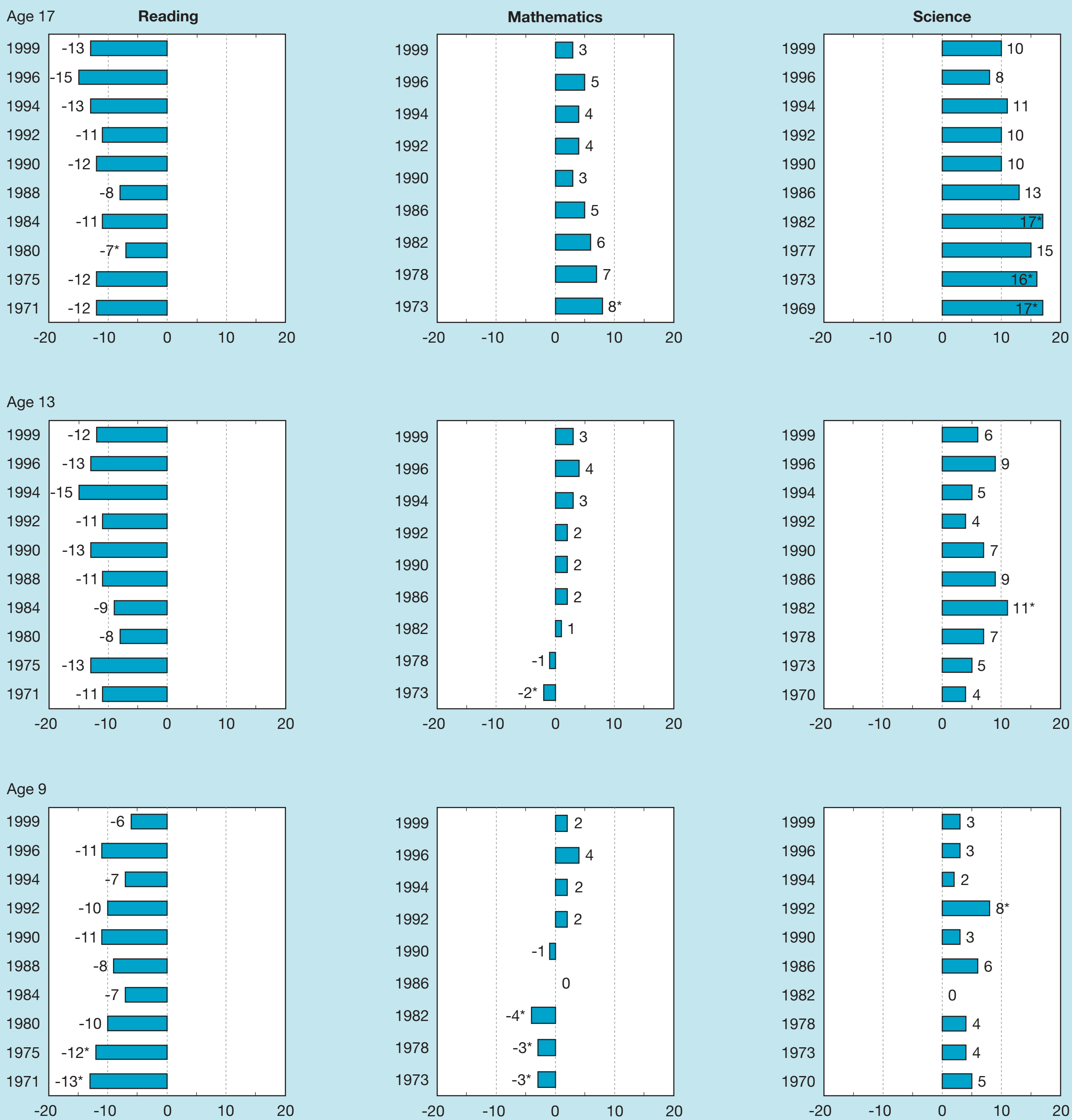
[1]Hispanics are a diverse group with considerable differences in country of origin, social class, race, educational status, and level of assimilation (Valdivieso and Nicolau 1992). What does characterize all the major groups except Cubans, albeit in varying intensities, are high levels of poverty and low levels of educational achievement. Although sample sizes in the data presented in this chapter do not allow the separate reporting of Hispanics by background characteristics, it should be acknowledged that there is a wide range of variability within this broad category. Sample sizes for Asians/Pacific Islanders and American Indians/Alaskan Natives are too small in the NAEP trends study to produce reliable estimates for these groups.

[2]Data from the 2000 NAEP Science Assessment were not available in time for inclusion in this chapter. The main findings were that 4th- and 8th-graders' scores remained stable between 1996 and 2000, while scores for high school seniors declined. See < http://nces.ed.gov/nationsreportcard/science/results/>. Accessed 11/26/01.

[3]A recent National Academy of Sciences-commissioned report found the current process of setting NAEP achievement levels to be "fundamentally flawed" (National Research Council 1998, 162). NAGB continues to use the mathematics achievement levels developed for the 1990 assessment, and they are used here because they so clearly highlight the widespread concern about the level of student performance in this subject.

Figure 1-2.
Trends in differences between male and female student average scale scores, by age, various years: 1969–1999
(Male minus female score)



*Significantly different from 1999. Small differences between male and female scores are often not statistically significant. For example the male-female differences were not statistically significant in 1999 for mathematics at all three ages and for 9-year-olds in science.

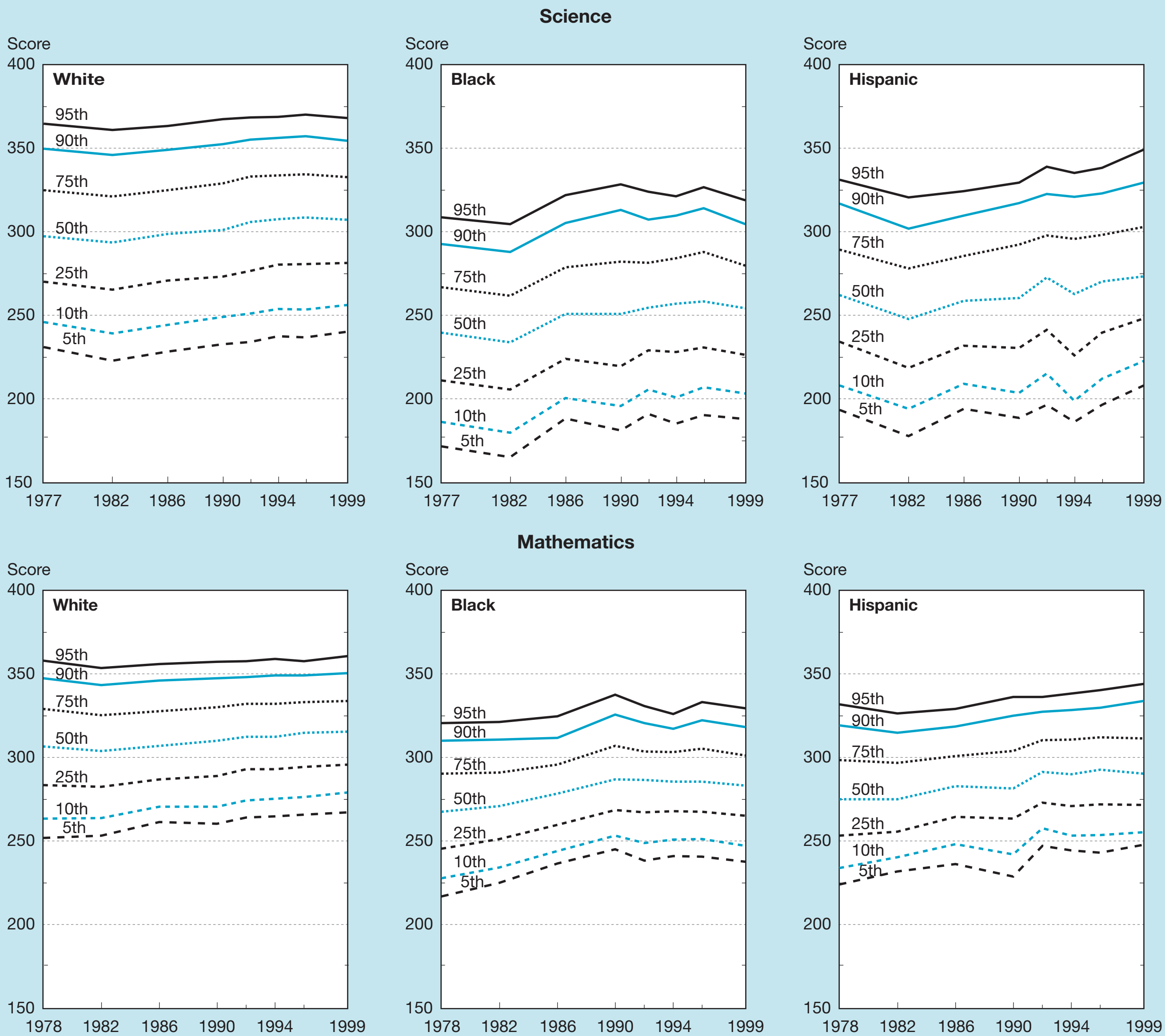
SOURCE: National Center for Education Statistics, *NAEP 1999 Trends in Academic Progress: Three Decades of Student Performance,* NCES 2000-469. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2000e.

Science & Engineering Indicators – 2002

formance on the National NAEP increased in the 4th, 8th, and 12th grades between 1990 and 2000. While the average scores of 4th and 8th graders made progress throughout the decade, the scores of 12th graders declined between 1996 and 2000, reducing some of the gain made between 1990 and 1996. The national average scale score for 4th graders in 2000 was 228, an increase of 15 points over the national average for 1990; the average scale score for 8th graders in 2000 was 275, an increase of 12 points; and the average scale score for 12th graders was 301, an increase of 7 points since 1990, but a decrease in 3 points since 1996 (NCES 2001f). The cross-decade increases of 4th and 8th graders are between a third and almost half of a standard deviation in test scores for these grades, roughly equivalent to a gain of between 1.5 and 2 grade levels. While smaller, the 12th-grade gain was still substantial, between 0.5 and 1 grade level.

Although these increases suggest that some progress is being made across areas emphasized in the NCTM mathematics standards, relatively few students scored at the Proficient or Advanced levels set by NAGB for each grade, and more than 30 percent scored below the Basic level. (See figure 1-4.) For 4th-grade students, the percentage performing at or above the Basic level was 69 percent in 2000 compared with 50 percent in 1990; for 8th-grade students, 66 percent compared with 52

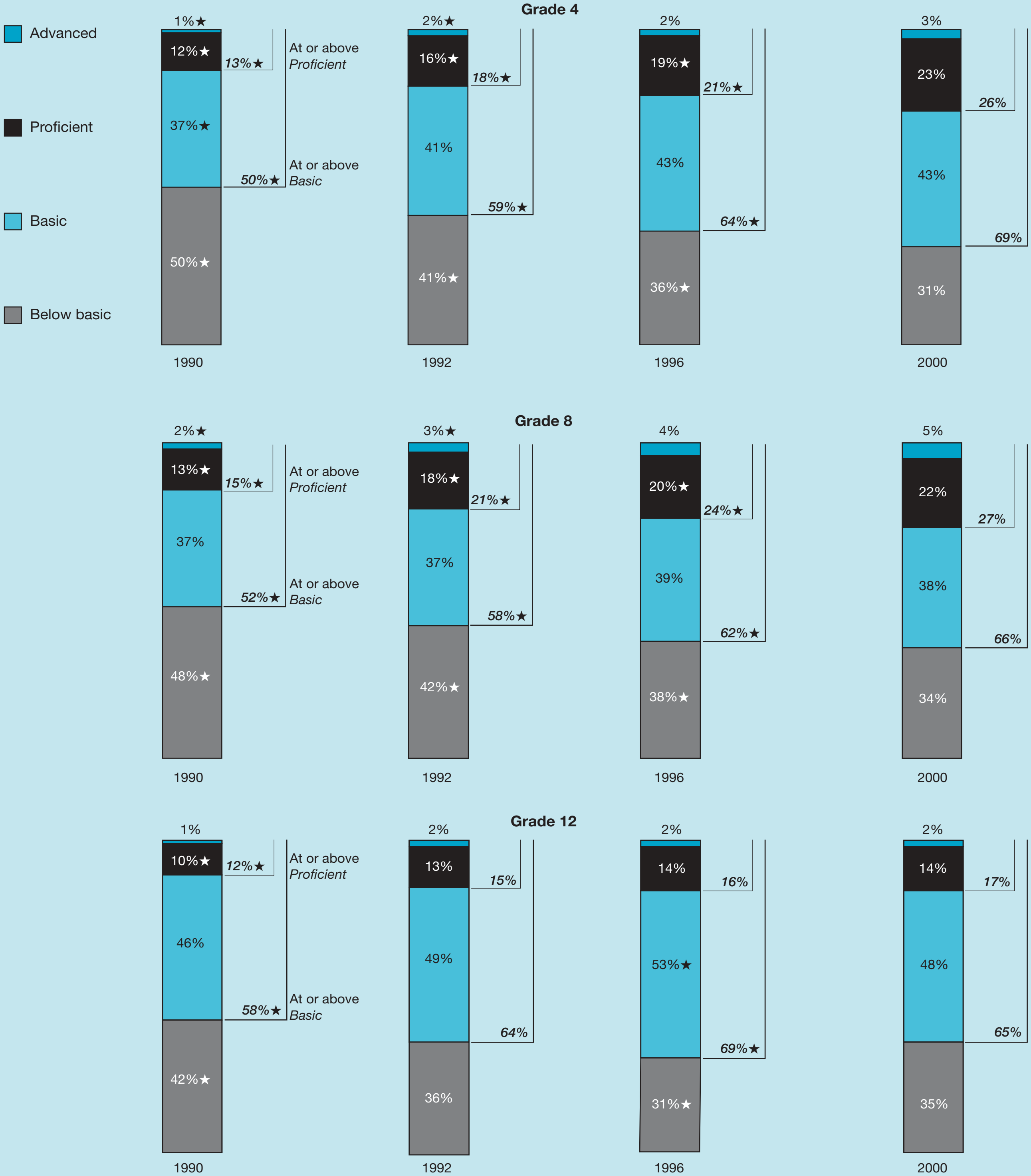
Figure 1-3.
Percentile distribution of science and mathematics proficiency for 17-year-olds, by race/ethnicity: selected years 1977–99



SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, summary data tables http://nces.ed.gov/nationsreportcard/tables/.

Science & Engineering Indicators – 2002

Figure 1-4.
Percentage of students within each mathematics achievement level range and at or above achievement levels, grades 4, 8, and 12: 1990–2000



How to read these figures:
The italicized percentages to the right of the shaded bars represent the percent of students at or above *Basic* and *Proficient.*
The percentages in the shaded bars represent the percentages of students within each achievement level.
★ Significantly different from 2000.

NOTE: Percentages within each mathematics achievement level range may not add to 100, or to the exact percentages at or above achievement levels, due to rounding.

SOURCE: National Center for Education Statistics, *The Nation's Report Card: Mathematics 2000,* NCES 2001-517, Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2001f.

Science & Engineering Indicators – 2002

percent; and for 12th-grade students, 65 percent compared with 58 percent. The percentages of students scoring at the Proficient and Advanced levels were much lower: 26 percent of 4th graders, 27 percent of 8th graders, and 17 percent of 12th graders scored at the Proficient level in 2000, and the percentage of students in these grades in 2000 scoring at the Advanced level were 3 percent, 5 percent, and 2 percent, respectively. From NAGB's perspective, then, as many as one-third of students continue to score below a Basic level of mathematics achievement, and few score at levels considered to be Advanced.

Proficiency levels provide an additional metric to gauge how wide the gaps in scores are between different subgroups. The NAEP sample shows differences in the achievement of boys and girls, students from different racial and ethnic groups, students from different states and jurisdictions, and students receiving and not receiving Title I services.

Proficiency by Sex

Although similar proportions of boys and girls scored at the Basic level or above on the 2000 NAEP mathematics assessment, boys were more likely to score at the Proficient or Advanced levels than girls at the 4th, 8th, and 12th grades. For example, 20 percent of 12th-grade males scored at the Proficient level compared with 14 percent of girls, and the percentage of each group scoring at the Advanced level was 3 and 1 percent, respectively. (See text table 1-1.)

Proficiency by Race/Ethnicity

At each grade level, a larger percentage of white and Asian/Pacific Islander students scored at the Basic, Proficient, and Advanced levels in 2000 than their black, Hispanic, and American Indian/Alaskan Native counterparts.[4] For example, while 34 percent of Asian/Pacific Islander and 20 percent of white 12th graders scored at or above the Proficient level in 2000, only 4 percent of Hispanic, 3 percent of black, and 10 percent of American Indian/Alaskan Native 12th graders scored at that level. Furthermore, there was no evidence in the 2000 assessment of any narrowing of the racial/ethnic group score gaps since 1990. These differences, combined with higher dropout rates for Hispanic, black, and American Indian/Alaskan Native youth, point to considerable disparities in achievement across racial/ethnic groups. However, there is substantial variation for ethnic groups by country of origin (see sidebar, "Variation in Educational Achievement and College Attendance Rates of Asian and Hispanic 1988 8th Graders by Country of Origin") and time since immigration. (The sidebar, "Generational Status and Educational Outcomes Among Asian and Hispanic 1988 8th Graders" compares ethnic groups by timing of immigration.)

[4]Sample sizes in the NAEP study are too small to report Asians by country of origin. Reporting a single category of all Asians/Pacific Islanders, however, "conceals complexities and differences in the lives of distinct Asian groups" (Carter and Wilson 1997).

Text table 1-1.
Percentage of 12th-grade students at each NAEP mathematics achievement level: 1990 and 2000

Year and characteristic	Advanced	Proficient	Basic	Below basic
Total				
2000	2	17[a]	65[a]	35[a]
1990	1	12	58	42
Male				
2000	3	20	66[a]	34[a]
1990	2	15	60	40
Female				
2000	1	14[a]	64[a]	36[a]
1990	1	9	56	44
Race/ethnicity				
White				
2000	3	20[a]	74[a]	26[a]
1990	2	14	66	34
Black				
2000	—	3	31	69
1990	0	2	27	73
Hispanic				
2000	—	4	44[a]	56[a]
1990	—	4	36	64
Asian/Pacific Islander				
2000	7	34	80	20
1990	5	23	75	25
American Indian/Alaskan Native[b]				
2000	—	10	57	43
Location (2000)				
Central city	2	16	60	40
Urban fringe/large town	3	19	68	32
Rural/small town	1	13	65	35

— = Percentage is between 0.0 and 0.5.

[a]Significantly different from 1990 at 0.5 level.

[b]Sample size is insufficient to permit a reliable estimate of 1990 values.

SOURCE: National Center for Education Statistics, *The Nation's Report Card: Mathematics 2000,* NCES 2001-517, Washington DC: U.S. Department of Education, Office of Educational Research and Improvement 2001e.

Science & Engineering Indicators – 2002

Proficiency by Type of Location

At the 4th, 8th, and 12th grades, students in the urban fringe/large town locations had higher scale scores on the NAEP national mathematics assessment than students in central city locations (NCES 2001f). At grades 4 and 8, students in rural/small town locations also outperformed their counterparts in the central city locations. These differences were also reflected in proficiency scores. (See text table 1-1.) For example, at grade 12, there were higher percentages of students at or above the Proficient level and at or above the Advanced level attending schools in urban fringe/large town locations (19 and 3 percent, respectively) than in rural school locations (12 and 1 percent, respectively). While 16 percent of 12th graders in central city

Variation in Educational Achievement and College Attendance Rates of Asian and Hispanic 1988 8th Graders by Country of Origin

Sample sizes in the National Assessment of Educational Progress (NAEP) trends study and the National NAEP are too small to report scores for Asians/Pacific Islanders and Hispanics by country of origin. Collapsing all Asians/Pacific Islanders and all Hispanics into homogeneous ethnic categories can conceal wide variation in outcomes by country of origin. Data collected in the National Educational Longitudinal Study of 1988 show mathematics and science achievement differences between Asian and Hispanic 8th graders from different countries of origin when tested in 1992. This study also compares college attendance rates between Asian/Pacific Islander and Hispanic subgroups. (See text table 1-2.) Data show the following.

Asians/Pacific Islanders

Although the aggregate group of Asians/Pacific Islanders scored as well as or higher than their white counterparts on assessments of mathematics and science in 1992, considerable variation was seen within this group by country of origin. For example, students with ancestry in China, Korea, and South Asia tended to have higher scores than Asians/Pacific Islanders as a whole, and Pacific Islanders had lower scores.

College attendance rates among Asians/Pacific Islanders also varied by country of origin. For example, nearly 9 out of 10 Chinese, Filipino, Korean, and South Asian students in the 8th-grade class of 1988 had enrolled in postsecondary education by 1992, compared with enrollment rates of only 50 percent for those from Pacific Islands.

Hispanics

Hispanic 8th graders with Cuban ancestry tended to have higher mathematics and science test scores than their Mexican American counterparts. Mexican American students also tended to have lower rates of postsecondary attendance than Hispanics with Cuban, Puerto Rican, or other ancestry.

SOURCE: NCES 2001e.

Text table 1-2.
Percentile scores on mathematics and science tests in 1992 and postsecondary enrollment rates by 1994 of 1988 8th-grade class, by race/ethnicity and country of origin

Race/ethnicity and country of origin	1992 Percentile score		Postsecondary enrollment rate by 1994
	Mathematics	Science	
All students	51	51	65
White	56	56	68
Black	33	29	57
American Indian/ Alaskan Native	29	29	35
Asian/Pacific Islander	60	54	83
China	76	65	94
Philippines	62	57	89
Japan	69	67	65
Korea	75	69	95
Southeast Asia	61	52	79
Pacific Islands	39	35	50
South Asia	71	66	91
Hispanic	39	37	54
Mexico	37	37	51
Cuba	53	46	66
Puerto Rico	42	41	65
Other	46	43	67

SOURCE: National Center for Education Statistics, National Education Longitudinal Study: 1988–94, Data Analysis System 2001d.

Science & Engineering Indicators – 2002

locations scored at or above the Proficient level, only 60 scored at or above the basic level, lower than the 68 percent in urban fringe/large town locations.

Because of slight changes by the Census Bureau in the definitions of these categories, schools were not classified in exactly the same way in 2000 in terms of location type as in previous NAEP assessments. Therefore, comparisons to previous years are not possible (NCES 2001f).

Proficiency by Free/Reduced-Price Lunch Eligibility

There is a wide gap between the NAEP mathematics scores of high- and low- income students, as measured by eligibility for the National School Lunch Program. At the 4th, 8th, and 12th grades, the scale scores for students who are not eligible for the Free/Reduced Price Lunch Program (i.e., those above the poverty guidelines) are significantly higher than the scores for the students who are eligible for the program. For example, low-income 12th-grade students (those who were eligible for the Free/Reduced Price Lunch Program) had scale scores similar to high-income 8th-grade students (those who were not eligible for this program). The size of these gaps can also be seen by comparing the percentage of students in each group at or above the Proficient level. While 35 percent of high-income students scored at or above the Proficient level, only 10 percent of their low-income counterparts did so. Furthermore, at each grade level, low-income students were twice as likely or more to score below the Basic level of achievement than were high-income students (NCES 2001f).

Proficiency by State

Wide variability exists across states in the proportion of public 8th-grade students performing above the Proficient level, and growth seen at the national level between 1996 and 2000 was not uniform across states. At grade 8, between 8

Generational Status and Educational Outcomes Among Asian and Hispanic 1988 8th Graders

Past research has consistently shown that, compared with Hispanics, Asian students perform better in school, have higher expectations for educational attainment, are more likely to graduate from high school, and are more likely to continue their education past high school (Sanderson et al. 1996, Green et al. 1995). Most of these studies, however, report statistics and findings without regard to differences within these groups, such as immigrant status (whether or not the student is foreign or U.S. born) and generational status (the number of generations the student's family has lived in the United States). A recent study from the National Center for Education Statistics (NCES) examined the relationship between the immigration and "generational" status of Asian and Hispanic students and various educational indicators and outcomes. Students were classified as:

- first-generation immigrant (born outside the United States);
- second-generation immigrant (U.S.-born students with one or both parents born outside the United States); or
- third-generation or higher immigrant (both parents and the student born in the United States). Students born in Puerto Rico who moved to one of the 50 states or the District of Columbia were classified as immigrants.

The analysis looked at how the generational status of Asian and Hispanic students from the 1988 8th-grade cohort of the National Education Longitudinal Study of 1988 (NCES 1999d) was associated with various educational outcomes as this cohort entered and progressed through high school and began postsecondary education. The analysis makes comparisons both *within* race/ethnicity and *between* generations on student background (family and language characteristics); 8th-grade experiences (8th-grade school characteristics, achievement test scores, and plans for high school); high school experiences (type of high school and graduation rates); postsecondary expectations (student and parental); and postsecondary enrollment. The results of this study are summarized below.

Student Background Characteristics

Nearly half of 8th-grade Asians in 1988 were born outside the United States, compared with about 18 percent of their Hispanic peers. Families of first-generation Asian 8th graders were more likely to be from Southeast Asia (23 percent), the Philippines (19 percent), China (19 percent), and Korea (11 percent) than from Japan (1.7 percent) or the Pacific Islands (1.6 percent). The families of third-generation (or greater) Asian 8th graders were more likely than their first-generation counterparts to be from other Asian countries, including India (50 percent), the Pacific Islands (21 percent), and Japan (12 percent). Hispanic immigrants tended to be more consistently spread across Hispanic groups: Mexican Americans, who made up a large proportion of each generation, ranged between 62 and 70 percent; Cuban Americans between 2 and 6 percent; Puerto Ricans between 5 and 17 percent; and Hispanics from other countries between 16 and 23 percent. Conclusions were as follows:

Family Background

- Asian students were more likely than Hispanic students to come from two-parent families and to have at least one parent with a college degree.
- First-generation students in each racial/ethnic group were more likely to come from families that lived at or below the poverty level than their second- and third-generation counterparts.

Language Characteristics

- Similar proportions of all 1988 8th-grade Asians and Hispanics were categorized as being limited-English proficient (LEP) (6 and 8 percent, respectively). However, Hispanics from this cohort were more likely than their Asian peers to come from homes where a language other than English was spoken (66 versus 55 percent).
- Similar proportions of first-generation Asians and Hispanics were LEP students (12 and 15 percent, respectively), but second- and third-generation Hispanics were more likely to be LEP students than were their Asian counterparts (10 and 5 percent versus 2 and 1 percent, respectively).
- The likelihood that a student's family spoke a foreign language in the home decreased for each racial/ethnic group when a family had been in the United States for three or more generations. Nonetheless, the rate at which Hispanics from different generations spoke only English in the home was consistently lower than that of their Asian counterparts.

Mathematics, Reading, and Science Proficiency

- Among all 8th graders, Hispanics were more likely than Asians to be below the proficiency level on the NELS mathematics and science assessment (25 versus 9 percent in mathematics and 41 versus 25 percent in science). Students at the proficiency level in mathematics understand simple arithmetic operations on whole numbers—essentially single-step operations that rely on rote memory. Students at the proficiency level in science have an understanding of everyday science concepts, e.g., "common knowledge" that can be acquired in everyday life.

- The proportions of Asians and Hispanics who tested below the proficiency level on the NELS reading assessment, however, did not differ significantly (14 and 19 percent, respectively).
- The gap between the percentages of 1988 Asian and Hispanic 8th graders scoring below the proficiency level on the NELS mathematics assessment appeared within each of the three generations.

Parental Education Expectations

- Overall, the parents of 1988 Asian 8th graders were more likely to expect their children to earn at least a college degree than were the parents of Hispanic 8th graders (76 versus 47 percent).
- The parents of third-generation Asian students were less likely than the parents of first- and second-generation Asian students to expect their children to earn at least a bachelor's degree (54 percent versus 81 and 86 percent, respectively). The parental expectations of Hispanic students did not differ significantly by generational status.

Postsecondary Enrollment

- As of 1994, among 1988 8th graders, Asian students were far more likely to have enrolled in postsecondary education in general and in a four-year institution in particular than their Hispanic counterparts.

First- and second-generation Asians in the 8th-grade class of 1988 were more likely than their third-generation counterparts to enroll in a postsecondary institution by 1994 (82, 91, and 63 percent, respectively). Enrollment rates for Hispanic students did not differ significantly by generation.

SOURCE: NCES 1999d.

and 40 percent of students in the 39 states participating in State NAEP were at or above the Proficient level in 2000. As shown in text table 1-3, thirty percent or more of public 8th-grade students scored at or above the Proficient level in Connecticut, Indiana, Kansas, Maine, Massachusetts, Minnesota, Montana, Nebraska, North Carolina, North Dakota, Ohio, Oregon, and Vermont, and 20 percent or less scored at that level in Alabama, Arkansas, California, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, Oklahoma, South Carolina, Tennessee, and West Virginia. Between 1990 and 2000, the percentage of 8th graders performing at or above the Proficient level increased for 30 out of 31 jurisdictions participating in both years. Some states made more progress than others, however. For example, the percentage of public 8th-grade students scoring at the Proficient level tripled in North Carolina over this 10- year period (from 9 to 30 percent), while the percentage scoring at that level or higher in North Dakota remained stable (at about 30 percent).

Summary of NAEP Performance

Although science and mathematics achievement has improved since the late 1960s and early 1970s, the percentage of students scoring in mathematics at a level considered proficient is still only about a quarter at the 4th and 8th grades and one in six in 12th grade. The gap in math and science proficiency between whites and Asians/Pacific Islanders and their black, Hispanic, and American Indian/Alaskan Native counterparts is particularly wide, as is the gap between students from low- and high-income backgrounds (as measured by eligibility for the National School Lunch Program). Although the gap between the scores of white and black students narrowed through the 1980s, there is evidence that the gap is now widening. The range between high- and low-performing students within a particular grade is particularly wide, pointing to a challenge for programs designed to hold all students accountable to high standards.

International Comparisons of Mathematics and Science Achievement

Internationally, U.S. student relative performance becomes increasingly weaker at higher grade levels. On the Third International Mathematics and Science Study (TIMSS), 9-year-olds tended to score above the international average, 13-year-olds near the average, and 17-year-olds below it. Even the most advanced students at the end of secondary school performed poorly compared with students in other countries taking similar advanced mathematics and science courses. This section reviews the mathematics and science performance of U.S. students, drawing primarily on the 1995 TIMSS and the 1999 repeat of this study at the 8th-grade level (TIMSS-R).

The 1995 TIMSS included assessments of 4th- and 8th-grade students as well as students in their final year of secondary school. The study included several components: the assessments, analyses of curriculums for various countries, and an observational video study of mathematics instruction in 8th-grade classes in Germany, Japan, and the United States. In addition to updating the comparison of U.S. math and science achievement in the 8th grade, the design of TIMSS-R made it possible to track changes in achievement and certain background factors from the earlier TIMSS study between the 4th and 8th grades. TIMSS-R also indicates the pace of educational change across nations, informing expectations about what can be achieved (NCES 2000f).

Text table 1-3.
Percentage of students at or above the proficient level in NAEP mathematics by state for grade 8 public schools: 1990–2000

State	1990	1992	1996	2000
National	15[a]	20[a]	23[a]	26
Alabama[c]	9[b]	10[b]	12	16
Arizona[c]	13[b]	15[b]	18	21
Arkansas	9[b]	10[b]	13	14
California[c]	12[b]	16	17	18
Connecticut	22[b]	26[b]	31	34
Georgia	14[b]	13[b]	16	19
Hawaii	12[b]	14	16	16
Idaho[c]	18[b]	22[b]	—	27
Illinois[c]	15[b]	—	—	27
Indiana[c]	17[b]	20[b]	24[a]	31
Kansas[c]	—	—	—	34
Kentucky	10[b]	14[b]	16[a]	21
Louisiana	5[b]	7[b]	7[a]	12
Maine[c]	—	25[b]	31	32
Maryland	17[b]	20[b]	24	29
Massachusetts	—	23[b]	28[a]	32
Michigan[c]	16[b]	19[b]	28	28
Minnesota[c]	23[b]	31[b]	34[a]	40
Mississippi	—	6	7	8
Missouri	—	20	22	22
Montana[c]	27[b]	—	32	37
Nebraska	24[b]	26[a]	31	31
Nevada	—	—	—	20
New Mexico	10[b]	11	14	13
New York	15[b]	20[b]	22	26
North Carolina	9[b]	12[b]	20	30
North Dakota	27	29	33	31
Ohio	15[b]	18[b]	—	31
Oklahoma	13[b]	17	—	19
Oregon[c]	21[b]	—	26[a]	32
Rhode Island	15[b]	16[b]	20[a]	24
South Carolina	—	15	14[a]	18
Tennessee	—	12[b]	15	17
Texas	13[b]	18[b]	21	24
Utah	—	22[a]	24	26
Vermont[c]	—	—	27[a]	32
Virginia	17[b]	19[b]	21[a]	26
West Virginia	9[b]	10[b]	14[b]	18
Wyoming	19[b]	21[b]	22[a]	25

— = Jurisdiction did not participate.

[a]Significantly different from 2000 if only one jurisdiction or the nation is being examined.

[b]Significantly different from 2000 when examining only one jurisdiction and when using a multiple-comparison procedure based on all jurisdictions that participated both years.

[c]Indicates that the jurisdiction did not meet one or more of the guidelines for school participation.

NOTE: National results are based on the national sample, not on aggregated state assessment samples. Comparative performance results may be affected by changes in exclusion rates for students with disabilities and limited-English-proficient students in the National Assessment of Educational Progress samples.

SOURCE: National Center for Education Statistics, *The Nation's Report Card: Mathematics 2000*, NCES 2001-517 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2001e).

Science & Engineering Indicators – 2002

Achievement of 4th- and 8th-Grade American Students in 1995

U.S. 4th-grade students performed at competitive levels in 1995 in both science and mathematics.[5] In science, they scored well above the 26-country international overall average as well as the average in all content areas assessed: earth sciences, life sciences, physical sciences, and environmental issues/ nature of science. Only students in South Korea scored at a higher level overall. The 4th-grade assessment in mathematics covered topics in whole numbers; fractions, and proportionality; measurement, estimation, and number sense; data representation, analysis, and probability; geometry; and patterns, functions, and relations. U.S. 4th-grade students scored above the international average on this assessment and performed comparatively well in all content areas except measurement (NCES 1997c).

As with 4th-grade students, the TIMSS science assessment taken by 8th-grade students covered earth and life sciences and environmental issues, but it also included content in physics and chemistry. With a mean score of 534 in science, 8th-grade U.S. students scored above the 41-country international average of 516. U.S. students performed at about the international average in chemistry and physics and above average in life sciences, earth sciences, and environmental issues (NCES 1996c).

Mathematics was the weaker area of 8th-grade achievement relative to the performance of students in other countries. The assessment covered fractions and number sense; geometry; algebra; data representation, analysis, and probability; measurement; and proportionality. Overall, 8th-grade U.S. students performed below the 41-country international overall average and at about the international average in algebra, data representation, and fractions and number sense. Performance in geometry, measurement, and proportionality was below the international average.

Change in Relative Performance Between 4th and 8th Grades

Change in the relative performance of U.S. students can be examined by comparing the average mathematics and science scores of U.S. 4th graders in 1995 and 8th graders in 1999 relative to the international average of the 17 nations that participated in 4th-grade TIMSS and 8th-grade TIMSS-R. (See sidebar, "How Comparisons Between 4th Graders in 1995 and 8th Graders in 1999 Are Made.") Figure 1-5 compares the average scores of the 17 nations between 4th-grade TIMSS and 8th-grade TIMSS-R with the international averages at both grades for each subject. The numbers shown in the figure are differences from the international average for the 17 nations. Nations are sorted into three groups: above the international average, similar to the international average, and below the international average.

[5]TIMSS results for 4th-, 8th-, and 12th-grade students have been widely reported, including in the previous volume of *S&E Indicators* (National Science Board 2000). TIMSS findings are outlined here in only general terms.

Figure 1-5.
Mathematics and science achievement for TIMSS-R 1999 countries/economies that participated in 1995 at both the 4th and 8th grades relative to the average across these locations

Mathematics

Country/economy	Fourth grade, 1995 Difference[a]
Singapore	73
South Korea	63
Japan	50
Hong Kong	40
Netherlands	32
Czech Republic	23
Slovenia	8
Hungary	4
United States	0
Australia	0
Italy	–7
Canada	–12
Latvia[b]	–18
England	–33
Cyprus	–42
New Zealand	–48
Iran	–130
Average	517

Country/economy	Eighth grade, 1999 Difference[a]
Singapore	80
South Korea	63
Hong Kong	58
Japan	55
Netherlands	16
Hungary	8
Canada	7
Slovenia	6
Australia	1
Czech Republic	–4
Latvia[b]	–19
United States	–22
England	–28
New Zealand	–33
Italy	–39
Cyprus	–48
Iran	–102
Average	524

Science

Country/economy	Fourth grade, 1995 Difference[a]
South Korea	62
Japan	39
United States	28
Australia	28
Czech Republic	18
Netherlands	17
England	14
Canada	12
Italy	10
Singapore	10
Slovenia	8
Hong Kong	–6
Hungary	–6
New Zealand	–9
Latvia[b]	–27
Cyprus	–64
Iran	–134
Average	514

Country/economy	Eighth grade, 1999 Difference[a]
Singapore	44
Hungary	28
Japan	25
South Korea	24
Netherlands	21
Australia	16
Czech Republic	15
England	14
Slovenia	9
Canada[c]	9
Hong Kong	5
United States	-9
New Zealand	–15
Latvia[b]	–21
Italy	–26
Cyprus	–64
Iran	–76
Average	524

Significantly higher than international average.
Does not differ significantly from international average.
Significantly lower than international average.

TIMSS = Third International Mathematics and Science study.

[a]Difference is calculated by subtracting international average of 17 locations from national average of each one.

[b]Only Latvian-speaking schools were tested.

[c]Shading may appear incorrect, but is statistically correct.

SOURCE: National Center for Education Statistics, *Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999*, NCES 2001-028, Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement: 2000f.

Science & Engineering Indicators – 2002

The available evidence appears to confirm what had been suggested four years ago: the relative performance of U.S. students in mathematics and science is lower in 8th grade than in 4th grade among this group of nations. In mathematics, the U.S. 4th-grade score in 1995 was similar to the international average of the 17 nations in-common between the 4th-grade TIMSS and 8th-grade TIMSS-R. At the 8th-grade level in 1999, the U.S. average in mathematics was below the international average of the 17 nations. Because U.S. 4th graders performed at the international average in 1995 and U.S. 8th graders performed below the international average in 1999

How Comparisons Between 4th Graders in 1995 and 8th Graders in 1999 Are Made

The Third International Mathematics and Science Study (TIMSS) and other studies before it have suggested that the international performance of the United States relative to other nations appears lower at grade 8 in both mathematics and science than at grade 4. These statements were based on comparisons of the relative standing of 4th- and 8th-grade students in the same year, as opposed to a comparison of the growth in scores of cohorts of 4th graders over time. TIMSS-R provides the opportunity to examine how the relative achievement of U.S. 4th-grade students in 1995 compares with the achievement of 8th-grade students four years later in 1999. Direct comparisons between the 1995 4th-grade assessment and the 1999 8th-grade assessment are complicated by several factors, however. First, the 4th-grade and 8th-grade assessments include different test questions. By necessity, the type of mathematics and science items that can be asked of an 8th grader may be inappropriate for a 4th grader. Second, because mathematics and science differ in the two grades, the content areas assessed also differ. For example, geometry and physics at grade 4 are different from geometry and physics at grade 8. Without a sufficient set of in-common test items between the grade 4 and grade 8 assessments (which is the way that assessments are equated across ages and grades in the National Assessment of Educational Progress), it can be difficult to construct a reliable and meaningful scale on which to compare 1995 4th graders to 1999 8th graders. Thus, comparisons in this section between 4th and 8th grade are based on the performance relative to the international average of the 17 nations that participated in 4th-grade TIMSS and 8th-grade TIMSS-R.

SOURCE: NCES 2000f.

in mathematics, this suggests that the relative performance of the cohort of 1995 U.S. 4th graders in mathematics was lower relative to this group of nations four years later.

In science, the U.S. 4th-grade score in 1995 was above the international average of the 17 nations in-common between the 4th-grade TIMSS and 8th-grade TIMSS-R. At the 8th-grade level in 1999, the U.S. average in science was similar to the international average of the 17 nations. Thus, U.S. 4th graders performed above the international average in 1995 and U.S. 8th graders performed at a level similar to the international average in 1999 in science. As in mathematics, this suggests that the relative performance of the cohort of U.S. 4th graders in science was lower relative to this group of nations four years later. The data also suggest that, in science, the relative performance of the cohort of 1995 4th graders in Singapore and Hungary was higher relative to this group of nations in 1999; the relative performance of the cohort of 1995 4th graders in Italy and New Zealand was lower relative to this group of nations four years later; and the relative performance of the cohort of 1995 4th graders in the 12 other nations was unchanged relative to this group of nations four years later.

Mathematics and Science Achievement of 8th Graders in 1999

For most of the 23 nations that participated in 8th grade in both TIMSS and TIMSS-R, including the United States, there was little change in the mathematics and science average scores over the four-year period. There was no change in 8th-grade mathematics achievement between 1995 and 1999 in the United States and in 18 other nations. (See text table 1-4.) Three nations, Canada, Cyprus, and Latvia, showed an increase in overall mathematics achievement between 1995 and 1999. One nation, the Czech Republic, experienced a decrease in overall math achievement over the same period. In the United States and 17 other nations, there was no change in the science achievement score of 8th graders between 1995 and 1999; while it increased in four countries and decreased in one.

Students' Achievement in the Final Year of Secondary School

Students' performance in the final year of secondary school can be considered a measure of what students have learned over the course of their years in school. Assessments were conducted in 21 countries in 1995 to examine performance on the general knowledge of mathematics and science expected of all students and on more specialized content taught only in advanced courses.

Achievement on General Knowledge Assessments. The TIMSS general knowledge assessments were taken by all students in their last year of upper secondary education (12th grade in the United States), including those not taking advanced mathematics and science courses. The science assessment covered earth sciences/life sciences and physical sciences, topics covered in grade 9 in many other countries but not until grade 11 in U.S. schools. On the general science knowledge assessment, U.S. students scored 20 points below the 21-country international average, comparable to the performance of 7 other nations but below the performance of 11 nations participating in the assessment. Only 2 of the 21 countries, Cyprus and South Africa, performed at a significantly lower level than the United States. Countries performing similarly to the United States were Germany, the Russian Federation, France, the Czech Republic, Italy, and Hungary.

A curriculum analysis showed that the general mathematics assessment given to students in their last year of secondary education covered topics comparable to 7th-grade material internationally and 9th-grade material in the United States. Again, U.S. students scored below the international average, outperformed by 14 countries but scoring similarly to Italy,

Text table 1-4.
Comparison of 8th-grade mathematics and science achievement, by country or economy: 1995 and 1999

Country/economy	1995	1999	Difference[a]
Mathematics			
(Latvia)[b]	488	505	17*
Hong Kong	569	582	13
(Netherlands)	529	540	11
Canada	521	531	10*
(Lithuania)[c]	472	482	10
United States	**492**	**502**	**9**
Cyprus	468	476	9*
Belgium	550	558	8
South Korea	581	587	6
(Australia)	519	525	6
Hungary	527	532	5
Iran	418	422	4
Russian Federation	524	526	2
Slovak Republic	534	534	0
(Slovenia)	531	530	–1
(Romania)	474	472	–1
(England)	498	496	–1
Japan	581	579	–2
Singapore	609	604	–4
Italy	491	485	–6
New Zealand	501	491	–10
(Bulgaria)	527	511	–16
Czech Republic	546	520	–26*
International average	519	521	2
Science			
(Latvia)[b]	476	503	27*
(Lithuania)[c]	464	488	25*
Hong Kong	510	530	20
Canada	514	533	19*
Hungary	537	552	16*
(Australia)	527	540	14
Cyprus	452	460	8
Russian Federation	523	529	7
(England)	533	538	5
(Netherlands)	541	545	3
Slovak Republic	532	535	3
South Korea	546	549	3
United States	**513**	**515**	**2**
Belgium	533	535	2
(Romania)	471	472	1
Italy	497	498	1
New Zealand	511	510	–1
Japan	554	550	–5
(Slovenia)	541	533	–8
Singapore	580	568	–12
Iran	463	448	–15
Czech Republic	555	539	–16
(Bulgaria)	545	518	–27*
International average	518	521	3

*1999 average is significantly different from the 1995 average.

[a]Difference is calculated by subtracting 1995 score from 1999 score. Detail may not add to totals because of rounding.

[b]Only Latvian-speaking schools were tested.

[c]Lithuania tested the same cohorts of students as other locations, but later in 1999, at the beginning of the next school year.

NOTES: Parentheses indicate countries not meeting international sampling and/or other guidelines in 1995, 1999, or both years. The international average is derived from the national averages of 23 locations.Tests for significance take into account the standard error for the reported differences. Thus, a small difference between the 1995 and 1999 averages for one location may be significant, whereas a large difference for another location may not be significant. The 1995 scores are based on rescaled data.

SOURCE: National Center for Education Statistics, *Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement From a U.S. Perspective, 1995 and 1999,* NCES 2001-028 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2000f).

Science & Engineering Indicators – 2002

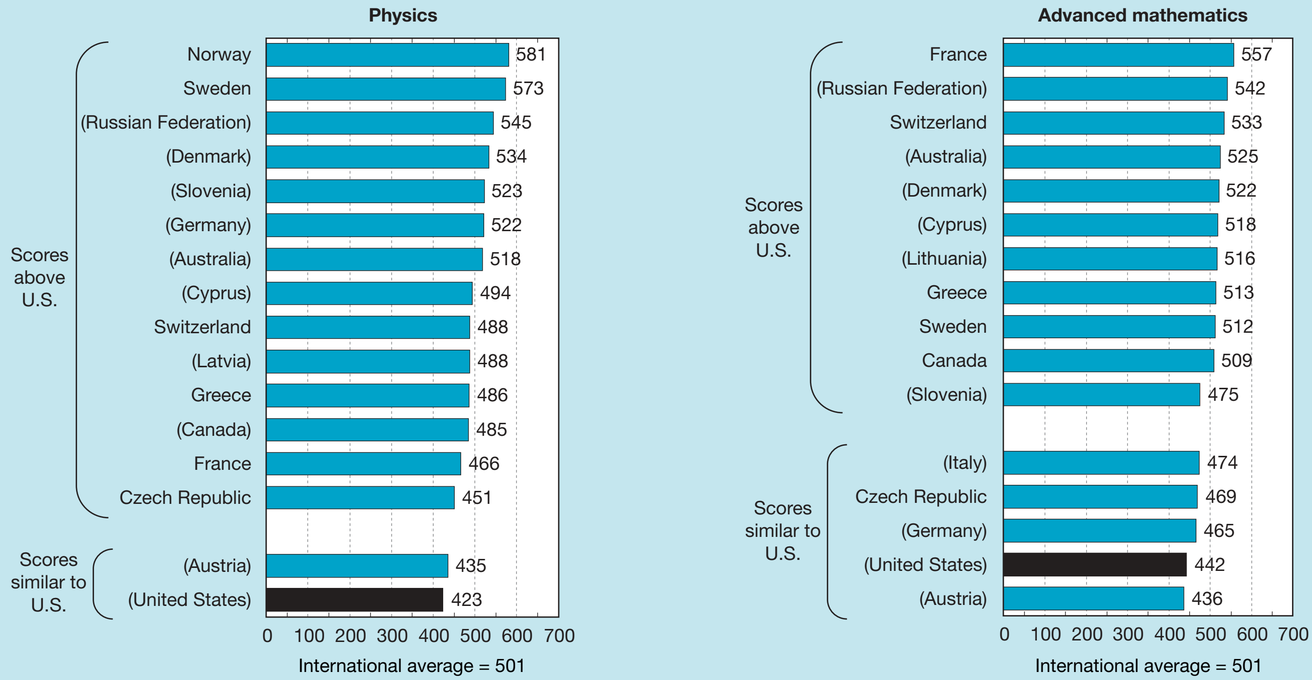
the Russian Federation, Lithuania, and the Czech Republic. As on the general science assessment, only Cyprus and South Africa performed at a lower level. These results suggest that students in the United States appear to be losing ground in mathematics and science to students in many other countries as they progress from elementary to middle to secondary school.

Achievement of Advanced Students. On advanced mathematics and science assessments, U.S. 12th grade students who had taken advanced coursework in these subjects performed poorly compared with their counterparts in other countries, even though U.S. students are less likely to have taken advanced courses than students at the end of secondary school in other countries. The TIMSS physics assessment was administered to students in other countries who were taking advanced science courses and to U.S. students who were taking or had taken physics I and II, advanced physics, or advanced placement (AP) physics (about 14 percent of the entire age cohort). The assessment covered mechanics and electricity/magnetism as well as particle, quantum, and other areas of modern physics. Compared with their counterparts in other countries, U.S. students performed below the international average of 16 countries on the physics assessment. (See figure 1-6.) The mean achievement scores of the United States (423) and Austria (435) were at the bottom of the international comparison (average = 501). Students in 14 other countries scored significantly higher than the United States. The subset of U.S. students taking or having taken AP physics scored 474 on the assessment, similar to scores of all advanced science students in nine other countries, and six countries scored higher (scores ranged from 518 to 581). Only Austria performed at a significantly lower level, with an average score of 435 (NCES 1998b). However, U.S. AP physics students represented a much smaller proportion of the age cohort in the United States (about 1 percent of the relevant age cohort) than did the students taking the advanced physics assessment in most of the other countries. For example, the physics assessment was taken by about 14 percent of the relevant age cohort in Canada, 20 percent in France, 8 percent in Germany, and 14 percent in Switzerland (NCES 1998b).

The advanced mathematics assessment was administered to students in other countries who were taking advanced mathematics courses and to U.S. students who were taking or had taken calculus, precalculus, or AP calculus (about 14 percent of the relevant cohort). One-quarter of the items tested calculus knowledge. Other topics included numbers, equations and functions, validation and structure, probability and statistics, and geometry.

The international average on the advanced mathematics assessment was 501. U.S. students, scoring 442, were outperformed by students in 11 nations, whose average scores ranged from 475 to 557. No nation performed significantly below the United States; Italy, the Czech Republic, Germany, and Austria performed at about the same level. (See figure 1-6.) U.S. students who had taken AP calculus had an average score of 513 and were exceeded only by students in France. Five nations scored significantly lower than the AP calculus students in the United States. Thus, the most advanced mathematics students in the United States (about 5 percent of the

Figure 1-6.
Average scale score on TIMSS physics and advanced mathematics assessment for students in final year of secondary school: 1994–95



TIMSS = Third International Mathematics and Science Study.

NOTE: Countries not meeting international guidelines are shown in parentheses.

SOURCE: I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith. *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics Study (TIMSS)* (Chestnut Hill, MA: Boston College, TIMSS International Study Center: 1998).

Science & Engineering Indicators – 2002

relevant age cohort) performed similarly to 10 to 20 percent of the age cohort in most of the other countries. In other words, U.S. calculus students performed at a level similar to a number of other countries, although the percentage of the relevant age cohort (e.g., 17-year-olds) taking the test was significantly lower than in other countries.

Summary of International Assessment Results

Data from TIMSS and TIMSS-R show that U.S. students generally perform comparatively better in science than in mathematics; that students in the primary grades demonstrate the strongest performance, especially in science; that students in grade 8 show weaker performance; and that those in grade 12 show weaker performance still, relative to their counterparts in other countries. Furthermore, while the United States tends to have fewer young people taking advanced math and science courses, students that do take them score lower on assessments of advanced mathematics and physics than do students who take advanced courses in other countries.

Science and Mathematics Coursework

Concerns about both the content and lack of focus of the U.S. mathematics and science curriculum, both as it is stated in state-level curricular frameworks and how it is implemented in the classroom, have appeared in major studies since the early 1980s (NCES 2000d). In 1983, the National Commission on Excellence in Education concluded that the curricular "smorgasbord" then offered in American schools combined with extensive student choice explained a great deal of the low performance of U.S. students (National Commission on Excellence in Education 1983).

Since the publication of *A Nation At Risk* nearly 20 years ago, most states have increased the number of mathematics and science courses required for high school graduation as a way to address this concern. A number of states and districts have also implemented "systemic" or "standards-based" reform efforts in order to align curricular content with student testing and teacher professional development. (See sidebar, "The NGA Perspective on Systemic, Standards-Based Reform"). This section examines state-level changes in curricular requirements, as well as changes in student course-taking patterns. While the impact of these changes on student performance is uncertain, it is clear that more students are taking advanced mathematics and science courses than they were two decades ago.